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Occupational Health in Ontario

Volume 10, Number 1, Winter 1989

Ergonomics: Designing with Workers in Mind

Ergonomic Issues Related to Patient Lifting

Occupational Health Hazard Survey of 51 Ontario Sewage Treatment Plants

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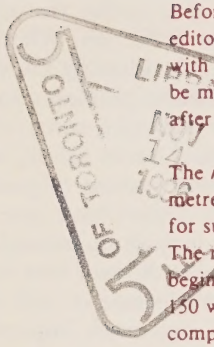

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Ergonomics: Designing with Workers in Mind

Summary

This paper has outlined a few examples of the contribution ergonomics can make to the workplace. The application of ergonomics—fitting the task to the worker—will contribute to worker health and safety and can increase the productivity and morale of the workplace. The paper details specific cases in which ergonomics has been successfully applied.

Key Words: ergonomics, productivity, injury, tools, lifting

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What is Ergonomics?

Tools, machines and equipment used in the workplace are often designed and built without any consideration being given to the people who will use them. Ergonomics is the science that studies the relationship between a worker and his or her job. When ergonomics is applied to designing or adapting the workplace to fit the worker, injuries, health problems and accidents can be prevented. For example, some workers use tools that leave their arms and hands aching at the end of the day. Some employees become fatigued from focusing on hard-to-see displays. Others have sore backs, necks and shoulders because they sit in uncomfortable seats or chairs. As workers cannot do their best when working in an uncomfortable workspace or with equipment that does not fit the body, ergonomic improvements can increase productivity, decrease the risk of injury and increase worker satisfaction.

Who Practises Ergonomics?

Almost everyone has practised ergonomics at some time. Maybe you have so organized your cupboards at home that the more frequently used items are easy to reach. Or maybe you have added a cushion to your car seat to make driving more comfortable. These 'common sense' actions are examples of applying the principles of ergonomics—fitting the task to the person—to everyday-life. The overwhelming number of factors that are present in the workplace—appropriate lighting, design of controls, seating and hand tools, workspace dimensions and lifting techniques—make the input of an expert, an ergonomist, necessary to attain the optimal solution. A diverse training in the sciences of anthropometry, physiology, biomechanics and psychology enables the ergonomist to consider all facets of a job. Through understanding the relationship between the workplace and the worker, an ergonomist can offer design suggestions for making the job better suited to the worker.

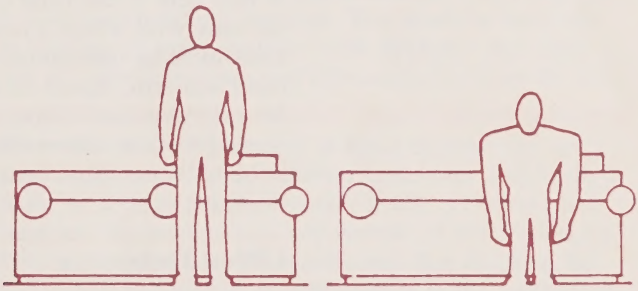
What Does an Ergonomist Do?

Three different aspects of a job—the work environment, the task demands and the worker population characteristics—interest the ergonomist. The work environment can place stress on a worker through agents such as noise, lighting and temperature. Task demands can be both physical and mental. Examples include the skill requirements of a job, its pace and the forces exerted by, and on, the human body during the course of work. Determination of work force characteristics—age, experience, attitudes and size—helps the ergonomist to assess the fit of the job to the worker population.

Ergonomics in Practice

An awareness of ergonomic principles can improve the comfort and safety of workers and the productivity of a workplace. For example, the lathe shown in Figure 1 has obviously not been designed with human characteristics in mind. Areas where ergonomics can be applied to improve the workplace follow.

Figure 1



The worker on the left is of average height and dimensions. The worker on the right is of ideal height and dimensions to reach all the controls and to operate the lathe effectively and efficiently: 4.5 ft. tall, 2 ft. across the shoulders and an 8 ft. arm span.

Work Posture

Holding any body position requires static muscle activity. Over long periods of time, this can lead to discomfort and fatigue. Note that in order to operate the lathe (Figure 1), the average worker would be required to bend over to reach the controls and see the work properly. Adopting a stooping posture for prolonged periods has a high potential for leading to injury. Maintaining

raised arms, reaching and hunching over are other positions of concern. Ergonomists can make recommendations for horizontal and vertical reach distances, work-surface height and leg room to reduce stressful postures. Adjustable work stations are beneficial in that they are able to accommodate workers of all sizes.

Repetitive Tasks

Jobs that require repetitive, forceful movements present a high risk of injury. The problem increases when they also require awkward postures. For the lathe operator (Figure 1), repetitive reaching to operate controls would be fatiguing. Properly designed tools and workspaces can reduce the need for awkward postures. As the effects of repetitive tasks may be additive over time, workers should rotate among dissimilar job assignments to minimize the time they spend using the same muscles in a repetitive task.

Hand Tools

A tool held in the hand can have significant effects on the ease with which a task can be completed. Hand tools must be compatible with the characteristics of the hand and arm. Based on research, recommendations for grip sizes and shapes of tools are available. Redesigning tools to reduce weight, vibration and the need for holding them with a bent wrist reduces the likelihood of injury.

Lifting Tasks

Lifting has long been recognized as a cause of workplace injuries. The physical demands of a lifting task depend on a combination of factors, including frequency of lift, load weight and posture of the worker. Although lifting with a straight back and bent knees has been advocated, workers should realize that this practice is not always appropriate. Reducing the horizontal distance between the load and the low back is the first priority. Ergonomic principles also recommend reducing the weight of the load and the distance through which it is lifted; the ideal range of movement should not extend below mid-thigh or above shoulder height. Twisting during a lift needs to be eliminated or minimized. Hand holds and proper footing can also reduce lifting accidents.

Displays and Controls

People and machines communicate through displays and controls. Ergonomics can be used to increase efficiency and reduce errors and accidents in automated processes. Unlike those shown in Figure 1, machine controls should be within easy reach. Also, there should be adequate space between controls, which should be arranged in a standardized way for similar vehicles or work sites. Displays should be easy to monitor, with symbols that are readily identified. Finally, tasks should be designed not only for workers who are alert, but also for those workers who may be fatigued from performing tasks for extended periods of time.

Environmental Factors

Sometimes, the conditions in which a job must be performed increase the demands on the worker. Work in a hot environment is much more difficult than work in a cool environment. Rest breaks and protective clothing are important in these situations. Proper lighting is also an ergonomic concern. Too much or too little or lighting of poor quality—with shadows and glare—can all cause eyestrain and increased errors on the job.

Ergonomic Success Stories

The early part of this paper defined ergonomics and presented several areas where ergonomics could potentially be used to improve worker health and safety and increase the productivity and morale of the workplace. This section focuses on several cases that illustrate the successful application of ergonomics in the workplace. These case studies outline the original job, the concerns with it, the changes made and the resulting improvements in injury rates and productivity.

Case #1: Redesign of a Hand Tool[1]

The Job: At Eastman Kodak Co. workers used a modified single-hole paper punch to notch sheet film. As many as 200 sheets of film had to be notched in a two-hour period.

The Concern: To use this tool, workers exerted a significant force to squeeze the punch handles together. The shape of the punch required the workers to bend their wrists and placed pressure on the tissues of the palm. Although no injuries had been reported, the injury potential was noted and design changes made.

The Changes: To reduce the risk of developing a repetitive strain injury, several design changes were made to the tool. The force required to close the handles was reduced. Lengthening the handles and adding wider grips covered with a rubberized material reduced the pressure on the palm of the hand. The handles were also bent so that workers could maintain a straight wrist posture.

The Results: These changes in tool design resulted in a 15 per cent increase in productivity. There was no evidence of further hand or wrist problems.

Case #2: Productivity and Ergonomic Improvement of a Packaging Line[2]

The Job: Eleven workers were involved in the packaging of eyeshadow. In order to improve productivity, the company was redesigning the packaging operation; ergonomics was used in this redesign effort. In the original system, operators either sat or stood along a 53-cm wide by 90-cm high conveyor. Chairs had no padding and could be adjusted only with the use of tools.

The Concerns: The seating design was poor, offering little back support. The thickness of the conveyor caused the workers' legs to be caught between the conveyor and the seat. The head and neck were bent forward more than 30 degrees, causing stress to the neck. Reach distances across the conveyor exposed workers to increased risk of shoulder injury. Frequent hand and wrist movements included pinch grips with bent wrists.

The Changes: The conveyor's height was lowered to 76 cm, allowing all workers to sit. The conveyor's thickness was reduced to 6.4 cm to allow sufficient space underneath for the thighs. Reach distances were reduced to 31.5 cm by decreasing the conveyor belt's width. The conveyor's edges were padded to provide armrests for workers. New chairs were padded and adjustable. Height adjustable footrests were also added to the work station. Five tasks were automated, reducing the need for the damaging hand and wrist actions.

The Results: Production was improved by 136 per cent, damaging arm and wrist motions decreased by 42.6 per cent for the left hand and by 26.4 per cent for the right hand. There was also a significant improvement in overall body posture as a result of the workstation changes.

Case #3: Ergonomic Involvement in Manual Handling of Sheet Metal in Fabrication Department[3]

The Job: A series of operations occur in the sheet metal fabrication department. Products are manually handled at each operation and must also be transported between operations. Sheets can be heavy, and they are awkward to handle.

The Concern: As products were handled several times in their fabrication, workers were exposed to the risk of back, arm and shoulder injury from lifting. The constant handling also slowed operations.

The Changes: Reduction of manual handling was achieved through the use of carts to transport the sheet metal. The carts were also used as work benches and were of such a height as to allow workers the option of sitting or standing. This eliminated the manual handling of the product at each operation and allowed efficient transport of materials between operations. A conveyor of equivalent height to the carts was used at the last operation. This allowed workers to slide the sheet metal from the cart to the conveyors, thereby eliminating the need to lift or carry the final product.

The Results: Reorganization brought about significant increases in productivity and profits. A reduction in labour costs of 10 per cent was attributed to ergonomics, as was an increase in productivity of 15 per cent. In addition, improvements in quality, though not documented, were reported.

Case #4: Workplace Redesign in an Assembly Operation[4]

The Job: In the manufacture of sandals, workers attach metal ornaments to the straps. Workers bend two prongs of the ornaments to fit them into holes in the strap before placing them in a pneumatic press for attachment. Several thousand ornaments are attached in a shift.

The Concern: Workers were experiencing discomfort in their hands, wrists, arms and neck. Risk factors in the job included high pinch grip forces, extreme wrist deviation, shoulder and neck tension, high repetition rate, high force per unit area and static loading of the legs and back.

The Changes: Workers were provided with easily adjustable chairs and footrests, as well as with armrests to reduce shoulder and neck tension. The press was angled 15 degrees and raised 5 cm so that the ornaments could be placed in it without wrist deviation. A parts bin, which eliminated extreme wrist flexion, was also provided. The ornament prongs were redesigned to eliminate the need to bend them before insertion.

The Results: Although changes in productivity and quality were not significant, workers no longer experienced postural discomfort. No further injuries have been reported since the changes.

Case #5: Ergonomics in VDT Work-station Design[5]

The Job: VDT operators were monitored during data entry tasks for a three-hour period while working at two different work stations. The operators had no rest breaks over this period of time. One work station represented a typical, non-adjustable work-station design, while the second was set up according to ergonomic principles.

The Concerns: The typical VDT work station included a standard, non-adjustable office chair, which had little support for the lower back. Wrist rests and document holders were not provided. The keyboard level and screen height were not appropriately placed for the operators, and lighting conditions resulted in glare in the workplace.

The Changes: The ergonomic VDT work-station design incorporated the following aspects. Lighting was improved. A chair, adjustable in terms of seat height and back rest height and tilt was provided, as were a document holder and wrist rests. The chair, keyboard height and screen height were individually adjusted to suit each operator and to maintain elbow height at approximately home row level.

The Results: The incorporation of ergonomic principles into the design of the VDT work station had a major impact on operator performance, for it improved by 24.5 per cent. In addition, there was a decrease in musculoskeletal complaints.

Résumé

Dans cet article, on donne quelques examples de l'influence de l'ergonomie sur le milieu de travail. Les applications de l'ergonomie—adapter le travail au tra-

vailleur—contribuent à améliorer la santé et la sécurité au travail; elles peuvent en outre accroître la productivité et rehausser le moral des travailleurs. L'article cite des cas détaillés spécifiques où l'ergonomie a été appliquée avec succès.

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Ergonomic Issues Related to Patient Lifting

Summary

Health care workers have a particularly high incidence of low back pain. The transferring of patients and residents is one activity that accounts for a significant percentage of the back injuries. This paper identifies many of the factors that affect the physical demands of patient handling and provides strategies for reducing the incidence of injuries.

Key Words: back pain, patient lifting, health care

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Low back pain is one of the most frequent ailments affecting people in their productive years.[1] For example, in 1985, back injuries represented 28 per cent of all claims for lost-time injuries made to the Ontario Workers' Compensation Board. In that year the board paid $420 million to cover compensation and health care payments for back injury claims. With an average of 50 lost days per back injury claim, there was a total of 3.1 million workdays lost in Ontario in 1985 as a direct result of back injury.[2]

Health care workers have a particularly high incidence of low back pain, and this has been related to the heavy physical demands of the work.[3] For health care workers in Ontario, back injuries accounted for 44 per cent of all lost-time injuries in 1985. When the total number of lost-time claims made by health care workers are analysed by occupation, 28 per cent of these claims are made by nursing aides and orderlies. Nurses account for 20 per cent of claims made by health care workers, and nursing assistants account for 11 per cent.[4] Dehlin et al.[5] attribute the extremely high risk of injury for nursing aides and orderlies to their direct involvement in the lifting and handling of residents and, more specifically, to lifting with the trunk flexed forward.

Lift and Transfer Techniques

There are several variables that combine to influence the physical demands of work tasks that involve the lifting and handling of loads. The specific characteristics of the load that contribute to the task demands include the actual weight being lifted, the weight distribution and stability of the load, the size and shape of the load, the coupling between the worker and the load, e.g. hand grip, the initial and final vertical location of the load and any significant horizontal distances the load is moved through. When the load is a resident, then some of the above parameters are not as easily defined as when it is, say, a box full of supplies. Other variables that influence the physical demands of the

task are the position of the load relative to the worker's body, the stability of the worker and the physical constraints of the work area that may restrict the worker's body posture. The duration of the task and the frequency with which it is performed further influence the physical demands placed on the worker.

Load Variables

The load weight is one of the most important variables contributing to the physical demands of a lifting or handling task. The physical size and shape, or bulk, of the load also contribute to the physical demands of the work task.

When lifting and handling residents, the stability of the load is often unpredictable. It is important that both the worker and the resident are fully prepared before beginning the lift or transfer. The furniture and aids used in a transfer, e.g. bed and wheelchair, should be secured to prevent unanticipated movement. Workers should try to anticipate sudden changes in the resident's ability to assist, body posture and movement patterns. If unpredictable resident action results in the worker's having to support more weight than he or she can safely handle, then it may be necessary to lower the resident slowly, even to the floor if necessary, in order to avoid injury to the worker and/or resident.

Biomechanical Variables

The position of the load relative to the worker's body is a very important factor in determining the physical demands of a lift or transfer task. Ideally, the weight should be supported between the knee and shoulder height of the worker. Lifting below knee height or above shoulder height is, physically, very demanding. Simply adjusting the height of the bed may enable the worker to adopt a more comfortable work posture and minimize the vertical component of the lift or transfer. The load should also be kept as close to the worker's body as possible. The further the load's centre of mass is from the worker's body, the greater the muscle exertion required when lifting and the greater the risk of injury to the worker. Therefore, the horizontal distances involved in the lift or transfer must be minimized.

Whenever possible, the worker should lift with the load directly in front of the body, i.e. symmetrically. It is generally believed that a load lifted against the side of the body, i.e. asymmetrically, is more hazardous to the musculoskeletal system than symmetric lifting

because of the combined effects of flexion, lateral flexion and the accompanying axial rotation of the spine. The resulting asymmetric loading of the back muscles is likely to result in higher local stress concentrations on the spine, which may put the worker at greater risk of injury.[6] Further, asymmetric lifting can cause poor postural stability. Workers should be encouraged to move their feet to keep the load in front of their body rather than lift while twisting at the waist.

The worker's initial posture and stability are very important when lifting or transferring a resident. To minimize the physical demands on the worker, equipment or furniture should be moved to permit the worker to adopt an unrestricted body posture. The workspace may also have to be rearranged to permit the use of a mechanical aid or assist. Female staff involved in a lot of resident handling tasks may find that wearing slacks permits a more unrestricted body posture than some of the more traditional dress uniforms. Proper shoes will help ensure that secure footing is maintained throughout the lift.

Worker Variables

The physical size and body dimensions of an individual can influence the biomechanics of a lifting task. An extremely tall individual, for example, may easily be able to lift a heavy box from a shelf that is above the shoulder height of a shorter worker. Within a worker population of women and men there is an extremely large range of body sizes and shapes. Muscle strength also varies significantly within the worker population, with male workers as a group generally being physically stronger than female workers. However, there is considerable overlap in strength between the strongest females and the weakest males. The endurance of an individual worker is also an important variable when examining physically demanding work tasks. Muscle fatigue reduces an individual's ability to perform heavy lifting. Both physical strength and endurance capability can, however, be increased if a worker is trained and regularly exposed to physically demanding work. Muscle strain and other injuries can reduce a worker's ability to perform physically demanding tasks.

Taking into account the full range of physical abilities within the worker population, criteria should be developed to ensure that the load lifted or transferred does not put the worker at risk of injury. If the lift or transfer is too physically demanding, then two or more workers

should be involved and/or an appropriate mechanical lifting aid should be used to support some or all of the weight.

Lift and Transfer Aids and Assists

Various types of mechanical aids and assists are available to make the manual lifting and handling of residents less physically demanding for the workers. The mechanical lifts typically support the full weight of the resident. Transfer aids or assists can be used to support a portion of the resident's weight, make supporting the weight easier and/or eliminate a portion of the movement or undesirable work actions.

Many facilities use wide 'lifting belts' to make it easier for staff to lift or transfer residents. The types of belts used range from standard vehicle seat belts to broad bands of tightly woven material fastened with velcro. The worker places a belt around the resident's waist and then grips opposite sides of the belt when performing the lift or transfer. These belts enable the worker to get a secure hand grip and, as a result, better control of the resident is gained. As the belt is positioned at a reasonable height for most workers and is also close to the resident's centre of gravity, it also helps to keep the load close to the worker's body.

Transfer boards are often used in assisting a resident into a car or in other situations where a resident must be moved in a lateral direction. Having a number of boards of different widths and lengths will accommodate the different physical dimensions of the specific areas in which they are used. Another very useful assist is a transfer disk, i.e. turntable, which allows the worker to pivot the resident. A transfer disk eliminates those situations where a worker might twist at the waist while supporting the weight of the resident.

Various types of slings are useful for some two-person lifts or transfers and they can also be used to supplement the standard slings that are provided with mechanical lifting aids. Often, the standard slings do not give the required stability for all residents, especially if muscle spasm or amputation interferes with the resident's balance or posture. Some slings may also restrict blood flow and contribute to skin breakdown. In these instances it may be useful to make new slings or to modify existing ones with padding, such as sheepskin covers, to eliminate some of these problems. In some facilities, the occupational therapy, laundry, workshop or maintenance areas can actually make or modify lift

and transfer aids. This allows the additional flexibility of custom designing aids or assists to meet a specific need.

Furniture and other components of a room can also be designed to assist staff when moving residents. One of the more standard 'hospital' adaptations is the use of an overbed trapeze, which allows residents to shift their weight and change body position while in bed. Other typical hospital design features include the provision of hand rails and grab bars. More asthetically acceptable, but equally functional, assists include the placement of well secured shelves and dressers that residents can use to help them stand. For residents with good upper body strength, well positioned pull cords securely fastened to the wall can allow some individuals to pull themselves up into a standing position, where they can then support themselves using a walker or other mobility aid. Beds that are height adjustable, drop sides on beds, removable arms on wheelchairs, etc. can assist the worker by minimizing the physical demands of the lift or transfer. Chairs of different heights, commode chairs, roll-in showers, pedestal tubs and other special tub designs, shower seats, etc. can further assist the worker by limiting either the number or the physical demands of lifts and transfers.

A wide variety of mechanical lifts are commercially available to support all, or a portion of, the resident's weight during a lift or transfer. Some of these aids are specifically designed for bathing residents and are used with specific types of tubs. Staff should ensure that the particular aid or equipment used for a lift or transfer is suited to both the individual resident's physical capabilities and medical status. In addition, it is important that the mechanical lift be physically compatible with the work area where it is to be used. For example, there must be adequate clearance under the bed or tub and enough clear area to allow the worker to manouever the aid into position.

Specific Techniques

Although resident care and safety is the primary concern in health care facilities, this can only be assured if the staff ensure their own safety. Situations may arise, for example, where staff are properly executing the designated lift or transfer and at the midway point of the movement, some unplanned resident action or other variable makes the transfer impossible to complete. In such instances it is critical that the established proce-

dures allow for the controlled lowering of the resident—even to the floor, if necessary. This acts to minimize the risk to both the resident and worker by allowing the worker to call for assistance or to reposition and establish control to perform the lift safely.

Most situations involving the physical lifting and handling of residents are not immediate and critical emergencies. However, 'urgent' situations can arise where there is only one worker available to lift a resident who requires a two-person lift. The various options in this type of situation should be thoroughly discussed with all staff. It should be reinforced that the safety of both the resident and the worker may be compromised if the worker attempts this lift alone. Assuming that it is not possible to get immediate assistance, the staff person can leave the resident and attempt to get help. There may be specific consequences of failing to lift the resident immediately. However, there are also potential consequences if the worker attempts to lift the resident alone. The worker may: (1) be completely unable to lift the resident, (2) may unsuccessfully attempt a lift and risk injury to the lifter and/or resident, or (3) with great physical strain, successfully complete the lift. The lifting procedures should address these situations and give workers firm guidelines for dealing with them.

Before attempting a lift or transfer the worker must first assess the situation and determine the specific lifting technique that should be used. The worker should then make the necessary adjustments to the height and position of equipment and furniture and prepare the resident for the lift. Where possible, the resident should be encouraged to assist with the lift or transfer. For example, existing muscle spasm in some paralyzed residents can actually be used to minimize the body weight that the worker must support during a transfer. Hemiplegic residents transferring from a bed to a wheelchair can often assist the worker by bearing weight on their unaffected side. If the bed height is lowered and one arm of the wheelchair is temporarily removed, these residents may need only minimal assistance. Although making these adjustments takes some additional time, this can greatly reduce the physical demands placed on the worker. Once the equipment, work area and resident have been adequately prepared, workers must ensure that their own body posture is correct and that they have secure footing before beginning the lift or transfer.

Many resident lifts and transfers require the involve-

ment of more than one worker. In these situations, proper co-ordination between the workers involved will reduce the physical effort required. One of the workers should act as a leader to direct the lift sequence and timing. The weight of the load should be evenly distributed between the workers.

A multidisciplinary team is often in the best position to develop procedures for lifting and handling residents. Creative input from ward supervisors, nurses, nursing assistants, orderlies, physicians, physiotherapists, occupational therapists and back education staff will help ensure that the methods adopted combine the best of technology and practical considerations. Directly involving the workers who perform most of the lifting and handling tasks will also help promote compliance with formal procedures.

Written Procedures

Detailed procedures should be developed to cover all potential lift and transfer scenarios. They should include methods for turning and repositioning, bathing, toiletting, dressing, administering treatments, transferring to cars or vans, and fire or other emergency situations. Depending on the physical size, abilities and medical status of the resident, the staff role in these situations can range from giving verbal or moral support to stabilizing furniture involved in a transfer to operating a mechanical lift or acting as a member of a team involved in a full manual lift. Residents with different physical abilities and medical conditions should be considered when developing a set of standard lift and transfer procedures. Although it is difficult to be exhaustive when developing specific techniques, it is important to have a basic core of lift and transfer methods that can be added to or modified as required. As many of the physical components of resident handling tasks cannot be changed, it is often necessary to limit the frequency and duration of these activities. The physical demands can often be kept to acceptable levels by regularly rotating staff between the physically demanding resident lifting and handling tasks and other less demanding work tasks.

Standard procedures for all lifts and transfers should be well documented in a procedure manual. Direct communication of these procedures through on-the-job training is important but cannot eliminate the need for formal written procedures. Although most health care facilities have procedure manuals, staff often view

them as an administrative necessity rather than a practical working tool. Often, photocopies of the manufacturer's sales brochures on mechanical lifts are the only material in the manual's section on mechanical lifting devices. This is not adequate. The manual should have many illustrations or pictures to ensure that specific techniques can be reviewed using either the illustrations and/or the written description. The procedure manuals should be readily available on each ward, and it is often useful to post specific pages for quick reference in specific work areas.

Systematic revision of lift and transfer procedures should begin with the lifts or transfers identified as inappropriate or not practical to use within the existing ward routines. Specific techniques associated with high numbers of incidents or injuries should also receive priority in the updating process. Staff involvement in the updating procedure promotes improved knowledge of existing procedures and development of practical alternatives based on direct work experience. Workers should be encouraged to identify parts of the manual that may need clarification or additional illustrations. One approach to revision of procedures involves all ward staff focusing on a specific lift or transfer procedure for a two-week period using a team problem-solving effort to develop alternatives. When this system is used within each ward, an informal creative competition between wards can help to generate additional interest. This type of active participation by the workers helps ensure that the reviewed procedures are usable and thus promotes adherence to the established techniques.

Resident Assessment

Most health care facilities use a 'resident care plan' or a similar method to document pertinent medical information on each resident. Although it is typically the RN or RNA who is responsible for updating this information, other health care staff also have access to the resident care plans. When workers are physically lifting and handling residents, the resident care plan should specify the exact procedures to be used.

A multidisciplinary team is best able to assess the capabilities of each resident and determine the lift and transfer techniques that are required. Potential team members include ward supervisors, nurses, doctors, aids or orderlies, physiotherapists/occupational therapists, back education staff, and even maintenance workers. The varied backgrounds, work experience and unique perspectives of these individuals can combine to determine

the best way to move the resident. As the safety of the resident is ensured only if the workers are not at risk of injury, the team should determine the methods that are best for the resident and that minimize the physical demands on the staff.

Although each resident may have specific lift or transfer techniques listed on their resident care plan, it is important that this information be readily available to all ward staff. Staff often report that they do not have the time or do not take the time to read the resident care plans. Given this reality, critical lift or transfer information must be translated to a readily accessible and easily interpreted form. Situations involving high resident turnover, frequent rotation of staff between wards or temporary assignments to cover employee absence make it even more important to have this information readily available to the workers.

There are many ways of presenting essential lift and transfer information so it can be readily accessible to the workers. Some facilities use 'line-o-vision' colour coding on the wall above the resident's bed. Coloured stick-on dots then indicate the resident's lift or transfer status. Ideally, the code should be designed so that even employees with defective colour vision can quickly decipher the code. For example, all lifts requiring two staff could be indicated by overlapping dots. Another colour and size of dot could be used to indicate potentially aggressive or violent residents. This information can be coded in the same way on wrist bands or on the mobility aids of the residents. Wool pompoms fastened to the end of the resident's pull cord used to alert the nursing station can be coded to indicate the resident's lift or transfer status and, at the same time, make it easier for the resident to grasp and pull the cord. Other features of the resident's room decor can also be coded if it is important to have an unobtrusive way of providing the staff with the essential information.

All staff should be personally responsible for immediately notifying their supervisor about any problems with performing the required lift or transfer or about any changes in the resident's health that may influence the lift or transfer status. The resident should then be quickly reassessed and the lift/transfer code changed if necessary. In situations of temporary illness, for example, a thin line could be put across the row of dots on the 'line-o-vision' to indicate that caution should be used when performing the coded lifts.

Equally important is the information that is passed on to ward staff following a shift change. Often, staff

do not have the training to translate the medical terminology used in these communications into practical information about how to lift or handle the individual. Supervisors must ensure that this very essential information is provided.

Education

Education is an essential part of any effort to reduce incidents and injuries related to the physical lifting and handling of residents. This should involve all staff and include promoting an awareness of general safety, formal back education, fitness and back exercise programs, ongoing in-service training, and instructional sessions on lift or transfer techniques. The joint health and safety committee is often in an ideal position to promote a co-operative venture with the support and active involvement of both management and workers. It is essential that the educational effort be ongoing, with frequent refresher sessions, rather than just involving formal training programs that are repeated once a year.

Staff are often totally unaware of the extent of a health or safety problem. The need to work safely could be reinforced by regularly making staff aware of the extent of various types of injuries on the ward. One method of increasing awareness could involve injured workers acting out their injury scenario with their colleagues and then discussing specific ways of preventing this type of injury. Workers are very receptive to learning from their peers rather than receiving all their instruction from supervisors.

Special back education sessions are often useful in facilities where there is a high incidence of back injuries or a lot of physically demanding work involving lifting and carrying tasks. If the trainer has been involved with injury investigations or has been a part of the resident assessment process, then this practical input will help ensure that the principles taught, and examples used, are relevant to the workers. Input from both workers and management is invaluable when developing these sessions. Class participants should evaluate the formal training sessions to help identify the focus for any course revision or updating. Safety training should become a part of the orientation given to all new employees.

In-service training is often the most useful way of providing ongoing and job-specific education. Employees often learn a new job best by working alongside an experienced staff member for a few days. Within a ward it may be useful to have an 'issue of the week' where all staff review, for example, various methods of bathing

residents. Short sessions during the week would then involve demonstrations and then practice of the formal lift or transfer procedures. These sessions are good opportunities for staff to bring up questions about the formal procedures or the appropriateness of the lift or transfer procedure designated for a specific resident.

If staff do not routinely use lifting equipment, they may forget the exact procedure or lose confidence about using an aid. The manufacturers or suppliers of the various aids and assists may be able to provide frequent refresher training for ward staff. Where a lift or transfer method has been adapted, e.g. using modified slings with a mechanical lift, all staff should be specifically instructed in this procedure.

The lifting and handling of aggressive or violent residents can lead to additional risks to staff. If workers are routinely involved with aggressive or violent residents, then specific training should be provided on this type of scenario. These sessions should focus on specific techniques that have been developed to minimize the risk of injury for both the worker and resident.

Incident and Injury Data

Detailed recording of all incidents and injuries involving resident lifts and transfers is an integral part of any injury prevention program. The reports might include personal information on the worker, such as height, weight, training, staff position, relevant details of footwear or clothing, training and length of employment. Other data that could be recorded include shift and exact time of the injury, length of time since last work break and recent absences due to illness, layoff or vacation. To help identify if the incident was related to inadequate staffing, the reports should note details such as staff shortages due to illness, or the presence of new staff on the ward. Some details about the resident that may also be useful include height and weight, current lift or transfer status, and any complicating factors such as unanticipated aggression or sudden change in medical status. Analysis of these data might help identify situations where specific characteristics of the resident contributed to the problem or where one resident is involved in multiple incidents or injuries. The exact location of the incident or injury, details of the equipment and work area involved and relevant interactions between the equipment, worker, resident and work area should also be noted.

Following an incident or injury, the supervisor should review the specific situation with the worker(s) concerned and make written recommendations for future

action. The worker should take refresher training if the event involved the use of improper procedures. It may also be useful to have the worker review the scenario with his or her colleagues during a short in-service training session.

It is very important that the injury and incident statistics are reviewed on a regular basis in order to identify high risk scenarios. As sick time is often the result of fatigue or muscle discomfort related to the work task, it is useful to review these data in conjunction with the injury and incident reports. Supervisors on each ward should receive monthly updates that compare the status of their staff with other areas within the facility. The joint health and safety committee should be actively involved in reviewing these data and recommending additional training or prevention strategies.

Maintenance

Routine maintenance of all wheelchairs, commode chairs, other lift and transfer aids, beds, carts, etc. is a very important part of injury prevention. All wheels and moving parts should be regularly checked and, where necessary, lubricated to ensure that they move smoothly and do not require the worker to use unnecessary force. These checks should also include the brake mechanisms of chairs and beds. A regular maintenance program can prevent unnecessary injury to residents, housekeeping staff and even therapy staff in addition to benefiting nursing staff.

Any staff member identifying a maintenance problem should follow a well established procedure to notify maintenance quickly and have the situation remedied within a satisfactory period of time. In some facilities it has been worthwhile to train a couple of workers on each ward in basic repair and routine maintenance. This enables some of the more simple maintenance duties to be performed on the ward.

Purchasing

Purchasing departments should involve the staff in determining the specifications for new purchases that are to be used in their work areas. As an example, the various workers involved with the beds may have the following specific concerns. Nursing staff will want to ensure that the new beds have sufficient clearance underneath to permit the use of mechanical lifting aids. Workers who routinely make up the beds may have a concern about beds with attached sides that do not swing down below the bottom of the mattress. Purchasing

staff may not be aware of the difficulty of operating the mechanical controls used to adjust the height and position of resident beds. Liaison with the ward staff may indicate the need to purchase a few beds with hydraulic control mechanisms that can be used for residents who must frequently have their bed controls adjusted. Nursing and housekeeping staff who may have to move the beds may also be concerned about the brake mechanism on the wheels. Implications for the maintenance staff should also be considered.

Very often it is useful to obtain a single lift or piece of equipment on trial to see if it is useful in a specific situation. Where possible, the suppliers should be encouraged to provide mini-training sessions for staff on the use, maintenance, cleaning and availability of new aids and assists.

Résumé

Les travailleurs des services de santé ont une incidence particulièrement élevée de douleurs du bas du dos. Un pourcentage important des blessures au dos est attribuable au fait qu'ils doivent transporter les patients et les pensionnaires d'établissements de santé. Dans cet article, on identifie un grand nombre des éléments de la manipulation des patients qui demandent un effort physique et on propose des stratégies visant à réduire le nombre des blessures.

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Occupational Health Hazard Survey of 51 Ontario Sewage Treatment Plants

Summary

Findings of field visits to audit worker exposure in 51 sewage treatment plants of Ontario are described.

The field visits were conducted according to the detailed checklists prepared by the Health and Safety Support Services Branch of the Ontario Ministry of Labour. Worker exposure to sewage, sewage sludge, and chemicals used for sewage treatment were reviewed, as were safe work practices and procedures related to the treatment processes. Ventilation, personal hygiene facilities, medical surveillance and education were also reviewed. In view of the low concentrations of several airborne pollutants, detailed investigations may be required.

Key Words: sewage chemicals, industrial hygiene, ventilation, protective equipment, education

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Introduction

This preliminary inspection survey was conducted by the Health and Safety Support Services Branch (HSSSB) to audit worker exposure arising from the processes in a representative sample of sewage treatment plants.

A total of 51 plants out of 400 sewage treatment facilities serving communities of different sizes were visited. The type of treatment varied from a single to a multi-stage facility according to the characteristics of the waste (quality and quantity) and the degree of purification required.

Primary treatment removes some of the solids and some of the organic materials. Secondary treatment removes most of the remaining solids and the organic material. Tertiary treatment removes any remaining contaminants to ensure an acceptable effluent. Disinfection of the effluent prior to final discharge is routine, and chlorine gas is normally used for this purpose. This report summarizes the findings based on written field visit reports and verbal confirmation by the field consultants.

Methods and Findings

In February 1987, HSSSB prepared checklists (see Appendix) for its consultants to assess potential health hazards present at the different types of sewage plants. The consultants followed the checklists in inspecting the 51 plants.

During the visits to these plants, worker exposure to sewage, sewage sludge, and chemicals used for sewage treatment were reviewed as well as safe work practices and procedures related to the treatment processes. Ventilation, personal hygiene facilities, medical surveillance and education were also reviewed. Table 1 shows the type of sewage handled in different plants.

Table 2 shows the number of plants, the names of the operators and range of working population; parentheses identify the plants with the largest population.

Table 1

Type of Sewage	No. of Plants
Mixed (domestic and industrial)	45
Domestic Only	6

Table 2

No. of Plants	Operated by	Range of Working Population
38	Local Municipalities	3–150 (Humber)
13	Ministry of the Environment	2–70 (Mississauga Lakeview)

Screens

Screens are used to remove materials that may damage equipment, interfere with the process or that are aesthetically undesirable in the effluent. At this operation the waste may give off hydrogen sulphide, methane, nitrogen and carbon dioxide; some hydrocarbons may also be present.

As can be seen from Table 3, out of 51 plants, 10 had screens located outdoors. Of the 41 plants equipped with screen rooms, 36 were provided with adequate mechanical ventilation. In two of the five plants without mechanical ventilation it was deemed necessary to advise the provision of adequate ventilation. Continuous air monitoring for the above pollutants was available in the screen rooms of 17 plants only.

Table 3

Screens		
No. of Plants	Location of Screens	Mechanical Ventilation
10	Outdoors	N/A
36	Indoors	Adequate
5	Indoors	Not Provided

Grit Removal

Grit such as sand, stones and gravel may find its way into a sewer system and be carried by the sewage to the treatment plant. Generally, grit removal units are installed after screening equipment to protect mechanical equipment from abrasion, avoid pipe clogging and reduce the sedimentation load on the primary clarifier.

Table 4 indicates that 16 plants had the grit removal operation carried out inside with adequate general ven-

tilation provided. In five plants this was carried out inside with no mechanical ventilation. In the remaining 30, the grit removal operation was carried out outside.

Table 4 **Grit Removal**

No. of Plants	Location of Grit Removal	Ventilation
30	Outdoors	—
16	Indoors	Adequate
5	Indoors	No

Primary Clarifications

The primary clarifiers remove, to varying degrees, the remaining solids in the raw sludge. The principle of operation is to slow down the sewage as it moves through the tank, allowing the suspended solids enough time to settle out. Floating solids and scum are also removed in these tanks. Sludge solids are directed to digesters and vacuum filters for further treatment.

Primary clarification is normally done outdoors. For outside processing there is usually no problem from worker exposure to airborne contaminants. An inside operation may generate H_2S, ammonia, methane and nitrogen from biological activity.

Table 5 indicates that only four out of 51 plants have primary clarifiers located indoors. Mechanical ventilation and air monitoring for generated contaminants were found to be adequate.

In one of the plants a polymer, Percol 757, is added prior to primary clarifiers for flocculation. Although this flocculent contains a trace of acrylamide, having a TWAEV of 0.03 mg/m^3 with 'skin' notation, worker exposure was considered to be minimal.

Table 5 **Primary Clarifiers**

No. of Plants	Location of Primary Clarifiers	Mechanical Ventilation and Air Monitoring
47	Outdoors	–
4	Indoors	Adequate

Secondary Treatment (Aeration and Clarification)

The breakdown of organic materials in the waste water takes place in this operation. This is achieved by bringing the organic materials into contact with the bacteria in the presence of dissolved oxygen for long enough to permit the breakdown to occur. The highest

number of airborne bacteria are expected in this area of treatment.

Table 6 shows that 48 plants have aeration tanks and hygiene facilities that are adequate. However, practices such as working downwind from the tank were followed in 15 plants and advice was given to provide proper instructions to the workers.

Table 6 **Aeration and Clarifiction**

No. of Plants	Aeration Tanks	Hygiene Facilities
3	No	–
48	Yes	Adequate

Chlorination

Effluent water from primary, secondary or tertiary clarifiers is disinfected before being discharged to a water coupe or, in the case of primary clarifiers, directed to aeration tanks.

Disinfection is usually done by using sodium or calcium hypochlorite. The consultants checked for employees' training in chlorine hazard, the use of personal protective equipment, air monitoring and ventilation for chlorine rooms, availability of SCBA and for safety procedures meeting the requirements of the Chlorine Institute.

As can be seen from Table 7, 50 plants were found to have adequate training for employees in handling chlorine, chlorine rooms equipped with air monitoring and ventilation, proper SCBAs available and appropriate safety procedures followed. One plant did not have formal training procedures and was advised to institute such procedures.

Table 7 **Chlorination**

No. of Plants	Training	Air Monitoring	Ventilation & SCBAs
44	Adequate	Adequate	Adequate
6	Adequate	Adequate	Adequate
1	Not Adequate	Not Adequate	Not Adequate

Sludge Treatment

Digestion

The primary purpose of sludge digestion is to reduce the complex organic matter present in the raw sludge (removed by sedimentation processes) to a simpler, non-objectionable state. Digestion produces a sludge

more amenable to dewatering, without nuisance, and it renders the sludge fit for easy disposal by lagooning, dewatering on sand beds, and direct application to farm lands, golf courses, parks, etc. Digestion also reduces the volume of sludge and, in doing so, produces methane gas, which can be utilized for heating purposes or gas engine operation. Digestion can be either anaerobic or aerobic and may produce hydrogen sulphide, methane, ammonia, carbon dioxide and nitrogen.

Table 8 indicates that a total of 39 plants contained digesters, of which, 37 plants had adequate control for methane gas, including ventilation and air monitoring.

Table 8 **Digesters**

No. of Plants	Digesters Present	Controls
12	No	–
37	Yes	Adequate
2	Yes	Not Adequate

Dewatering

Sludge solids are separated in some cases from the liquid portion of the sludge by settling in decant tanks, and then by being dewatered to 65 per cent moisture content on vacuum filters. The resulting cake is sterile and may be disposed of on land or by other convenient methods.

At present, there are several methods available to dewater sludge. These methods include:

1. Drying Beds
2. Vacuum Filtration
3. Centrifuging
4. Sludge Lagoons
5. Heat Drying

Table 9 shows that 38 plants did not have a dewatering process. Of the remaining 13 plants, nine had adequate control measures, including the availability of MSDSs to the workers, and staff in four plants were advised to procure proper MSDSs and provide adequate control measures for airborne contaminants.

Table 9 **Dewatering**

No. of Plants	Presence of Dewatering	Controls
38	No	–
9	Yes	Adequate
4	Yes	Not Adequate

Incineration

Incineration is a popular method of sludge disposal at very large sewage plants. It has the advantages of odourlessness, independence of weather and reduced volume and weight of the disposable end-product.

Incineration is achieved by the use of flash type incinerators, which are similar to flash type dryers but which operate at a temperature of approximately 871°C, and multiple-hearth furnaces, where the sludge is burned to an ash.

Only one of the 51 plants visited had incinerators. Poor ventilation was detected at the firing floor, basement and sub-basement floors. Some silica sand is used in the fluidized beds, but exposure to silica was considered unlikely.

Pump Rooms and Galleries (Excluding Wet Wells)

Table 10 shows that 22 plants did not have pump rooms. In 26 plants the provision of ventilation and personal protective equipment during maintenance work was adequate. The remaining three plants were advised to provide adequate mechanical ventilation for the pump room, continuous area monitoring for exhaust and make-up air, and hand and eye protection for dismantling the raw and return sludge pumps. One report indicated that the insulation in the pumping station contained asbestos; however, there was very low potential exposure.

Table 10 — **Pump Rooms and Galleries (Excluding Wet Wells)**

No. of Plants	Ventilation	Air Monitoring	PPE
26	Adequate	Adequate	Adequate
3	Inadequate	Inadequate	Inadequate
22	–	–	–

Wet Wells

As can be seen in Table 11, 18 of the 51 plants investigated did not have wet wells. In 31 plants wet wells were identified as confined spaces, and written procedures meeting the requirements of the Industrial Regulation and the Act were available. In the remaining two plants, orders were issued regarding continuous area monitoring for combustibles, adequate mechanical ventilation, proper procedure for rescue using SCBA and use of portable detectors.

Table 11 — **Wet Wells**

No. of Plants	Presence of Wet Wells	Procedure for Confined Space
18	No	–
31	Indoors	Adequate
2	Indoors	Inadequate

Personal Hygiene and Safety Precautions

Employees in 34 plants were provided with adequate personal hygiene facilities and safety equipment. In 17 plants provision and use of larger locker/shower areas, eyewash fountains in the ferric chloride and chlorine rooms, hygiene facilities, faceshields for workers in the ferric chloride room, impervious gloves and eye protection during maintenance work were advised.

Chemical Storage (Excluding Chlorine Room)

Table 12 shows that, in addition to a chlorine room, a separate chemical storage room is provided in 37 plants and ventilation was considered to be adequate.

Table 12 — **Chemical Storage**

No. of Plants	Chemical Storage	Ventilation
33	Yes	Adequate
4	Yes	Adequate
14	No	–

Education

In 47 plants the training of workers, including the Ministry of the Environment courses, is provided. These plants have adequate ongoing training procedures. In four plants advice was given to ensure provision of adequate training and ongoing safety instruction on the handling of chemicals in use.

Medical Surveillance Program

In all 51 plants preplacement medical examinations are conducted. There is no periodic or regular medical surveillance provided. The medical consultants of HSSSB advised the following:

1. Immunization for tetanus and polio.
2. Worker choice of his/her own physician.
3. Maintaining and updating immunization programs.
4. The need for the examining physician to provide the employer with an assessment of whether the worker

is fit, fit with limitations or unfit to work, without giving or disclosing to the employer the records or results of the examination or tests.

5. Periodic medical surveillance consisting of medical history and physical examination, and clinical tests as determined by the examining physician for all workers exposed to sewage sludge.

Summary of Findings

The findings may be summarized as follows:

1. Ninety-two per cent of the plants have adequate training in handling chlorine.
2. Hydrogen sulphide and methane are well controlled in most of the plants. Chlorine is also adequately controlled in the majority of plants.
3. Procedures for entry into confined spaces are well established in most of the plants, including the use of SCBA. Personal protective equipment is adequately provided in the majority of workplaces.
4. Health and safety committees are present in all the surveyed plants.
5. Adequate ventilation and air monitoring are available in all of the chlorine rooms of surveyed plants.
6. Preplacement medical examinations are conducted in all the surveyed plants, but no regular or periodic medical examinations thereafter.

Conclusion

This preliminary inspection enabled the Ministry of Labour to evaluate the adequacy of controls in water pollution control plants and advise and order improvements as necessary. Since most of the air pollutants are very low in concentration, it was difficult to estimate the effect of mixed exposures. Further investigations may be required to evaluate accurately the worker exposure present in these and other sewage treatment plants.

Appendix

Checklist for OHB Consultants Specific to Sewage Treatment Plants

1. Is there a screen room? If yes,
   a) is there mechanical ventilation?
   b) is there routine air monitoring for H_2S?
   c) is there an emergency evacuation procedure in the event of ventilation failure?

d) is the raking and removal of waste done manually, if yes—is protective equipment provided (skin)?
e) how frequent is the material collected in the dumpster taken away (preferably twice daily to prevent putrification)?

2. Is grit removal done inside a building? If yes, is there mechanical ventilation?

3. Is sedimentation and sludge formation done indoors? If yes,

a) is there mechanical ventilation?
b) is there routine monitoring for H_2S, methane, nitrogen, ammonia?

4. Are there aeration tanks? If yes,

a) have workers been instructed to work downward from the tanks?
b) are operators and maintenance workers following good personal hygiene practices?
c) are there sufficient hygiene facilities provided (wash basin, shower, emergency eye wash, segregated lunch rooms, eating, drinking and smoking policy, change room and clothing provision and cleaning)?

5. Is chlorine used? If yes,

a) is it chlorine gas or salt?
b) do workers receive training on the safe handling and the proper use of protective equipment?
c) are there air monitors, alarms and ventilation in all rooms where chlorine is used or injected?
d) is self-contained breathing apparatus (SCBA) available near the chlorine room?
e) do the safety procedures followed meet the requirements of the Chlorine Institute?

6. What are the steps followed in sludge treatment?

a) Is a digestion process involved? If yes,
– is there mechanical ventilation in the control room?
– is methane gas under control (to prevent explosion hazard)?

b) Is a dewatering process involved? If yes,
– is there mechanical ventilation in the filter press room?
– is the operator control room pressurized with filtered air?

- are chemicals such as ferric chloride or lime used to precondition the sludge prior to dewatering? If yes, are workers familiar with the safety data sheets and precautionary measures required?

c) Is there an incineration process? If yes,
- are maintenance operators provided with suitable protective clothing and equipment?
- is there a policy to restrict access to areas where repair of equipment is done?

7. Are there pump rooms and galleries? If yes, is dilution ventilation available?

8. Are there wet wells? If yes, is there a policy to identify wet wells as confined spaces to meet all the requirements of the Act and regulation?

9. Are there storage areas for chemicals? If yes, is the storage room well ventilated?

10. Are there hygiene facilities?

- change rooms for street and work clothes separated by a shower?
- separate lunch room?
- safety shower?
- emergency eye wash?

11. Are the workers provided with:

- coveralls?
- safety footwear?
- gloves?
- hard hat?
- safety glasses?

12. Is there a training policy for operators?

- course by MOE?
- safety instructions on the handling of chemicals in use?

13. Is there a medical surveillance program? If yes, does it include:

- physical examination?
- clinical tests?
- immunization?
- health education?

Résumé

Dans ce document on décrit les conclusions tirées à la suite de visites menées dans 51 usines d'épuration des eaux d'égouts pour vérifier le degré d'exposition des travailleurs à certaines substances.

Les visites ont été menées selon une liste détaillée de vérification préparée par la Direction des services de soutien de la santé et de la sécurité au travail du ministère du Travail de l'Ontario. On a étudié le degré d'exposition des travailleurs aux eaux d'égouts, aux boues et aux produits chimiques utilisés pour le traitement des eaux de même que les méthodes et procédés sécuritaires de travail en ce domaine. La ventilation, les installations d'hygiène personnelle, la surveillance médicale, l'éducation et la formation ont aussi fait l'objet de l'étude. En raison des faibles concentrations de polluants aéroportés, il se peut qu'il soit nécessaire de mener des études approfondies.

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Book Reviews

Toxicology of the Lung.

Target Organ Toxicology Series.

Published by Raven Press, New York, 1988.

Asking a devout clinician to review a book that essentially deals with basic science can be regarded as either an admission of defeat in finding someone better equipped intellectually to deal with such a task or a perfidious attempt to get the reviewer to plow through the book in order to make some sense of it.

Here is the first surprise: It is a very READABLE book. Equations and chemical formulae aside, every chapter is lucidly written and can be read with relative ease, even by the uninitiated.

The other surprise is the uniformly high quality of the pictorial aspects of the book.

The photographs, diagrams, tables and figures are all of first order; clear, concise, uncluttered and informative.

I found the chapter dealing with fibrogenic dusts a bit skimpy, but that may be due to *deformation du metier* on my part.

Of considerable interest was the chapter on Antioxidant Defense Mechanisms of the Lung, some aspects of which were discussed during the recent VIIth International Pneumoconioses Conference held in Pittsburgh.

As a clinician, I appreciate the conciseness of the chapters, each of which gives an overview of the problem discussed therein. A fairly extensive bibliography at the end of each section makes a search for additional information a pleasure.

Some of the basic facts contained in this book can be found in standard texts, of course.

The rest, however, is unique and provides a valuable addition to any library on occupational diseases.

W. Maehle

Medical Toxicology. Diagnosis and Treatment of Human Poisoning.

Matthew J. Ellenhorn and Donald G. Barceloux.

Elsevier, 1988.

As mentioned in the foreword (by Professor Chantal Bismuth of the University of Paris), this book will certainly be a reference for clinical toxicologists in the years to come.

In keeping with the main thrust, which focuses on acute poisonings, the initial chapter begins with facts and figures about poisoning causes, hospitalizations and

fatalities (both accidental and intentional), reminding us that, in the U.S. in 1985, the route of poisoning was by ingestion in 79 per cent of cases and that the most frequent causes of death were overdoses of antidepressants, analgesics, sedatives and hypnotics, and inhalation of carbon monoxide. Some causes, such as hydrocarbons, lead and carbon monoxide, can be related to work.

The chapter also lays out the basic approach to the support and stabilization of the poisoned patient (evaluation of the airway, ventilation, circulation, CNS depression, and so on).

Chapter 4 describes enhancement of elimination of poisons (such as forced diuresis, hemodialysis, hemoperfusion, plasma exchange and hyperbaric oxygen), the latter being indicated for carbon monoxide. Chapters follow on antidotes, more detail on supportive care, and pharmacokinetics.

Chapter 8, dealing with toxic exposure during pregnancy, includes a section on reproductive toxicology, tables on occupational exposures that may affect the male reproductive system and agents that may induce adverse reproductive outcomes from occupational exposure during pregnancy. However, the tables are adapted from a 1979 book, nine years old at the time of publication.

Almost half of the book is taken up by Part II, which deals with Therapeutic Drugs in chapters on drug classes, including acetaminophen, antiarrhythmic agents, anticoagulants, antihypertensive drugs, antiinfective drugs, muscle relaxants, antidepressants, and so on. The chapters consist of sections devoted to individual drugs and cover structure, use, product formulations, pharmacokinetics, clinical presentation of poisoning, laboratory analytic methods for detection, and the treatment of poisoning/overdose itself. Part III deals in a similar fashion with drugs of abuse, and Part V with natural toxins.

Part IV, dealing with chemical products, is of the most interest to readers of this journal. This part includes chapters on alcohols and glycols, airborne toxins, hydrocarbon products, metals and pesticides. Unfortunately, as might be expected in a book covering such a variety of compounds, the treatment is too limited to do justice to many of these hazards or disorders. For example, within occupational lung disease (19 pages), occupational asthma is covered by one page of text and two more of tables, while pneumoconiosis is allotted about three pages, including one on asbestos-related disease. Silicosis is merely mentioned in a table, and

in the text only in connection with other causes of simple and complicated pneumoconiosis. For other chemicals, e.g. toluene or trichloroethane, there are surprisingly comprehensive reviews, one to three pages in length, of the clinical presentation and treatment of acute and chronic effects. This could be useful for a brief overview, but, in some cases, more in-depth treatment, especially of chronic effects, might be found in textbooks of industrial toxicology, occupational lung disorders or occupational medicine. However, *Medical Toxicology* has the advantage of including a section on treatment of acute exposures or overdose.

In summary, this volume deals primarily with the presentation and treatment of acute intoxication, which might make it a valuable reference for poison control centres and hospital emergency departments. For the occupational health professional seeking the toxicological and epidemiological evidence for chronic effects of workplace compounds, more detail from other sources would be required in most cases.

G.M. Liss

Recent Publications Available from the Government Book Store

Regulations	Regulation for Roll-Over Protective Structures—made under the Occupational Health and Safety Act Ontario Regulation 524/88
	Regulation for Window Cleaning—made under the Occupational Health and Safety Act Ontario Regulation 527/88
Support Literature	Roll-Over Protective Structures: A Guide to the ROPS Regulation
	A Guide to the Window Cleaning Regulation

News and Notes

A Guide for Medical Examination for Respirator Use

A worker who is required to use and wear a respirator and who experiences breathing difficulties may request to be examined by a physician to determine if he can use and wear the respirator.

It should be noted that this type of medical examination is not intended for the purpose of determining the respirator fit. To accomplish this, qualitative and quantitative fit tests are used to determine adequate protection, and such tests form part of a company respirator protection program.

The examining physician has to consider the following factors when taking the medical/occupational history and conducting the medical examination for fitness to use a respirator.

A. Occupational Factors

1. The type of respiratory protection to be used.

   The use of any type of respirator may impose some physiological stress on the user, e.g.

   a) An air purifying respirator makes breathing more difficult because the filter or cartridge impedes the flow of air.
   b) An open circuit pressure demand respirator requires the wearer to exhale against significant resistance.
   c) A self-contained breathing apparatus (SCBA) is heavy, so it can be a burden to the user and can increase the worker's physical demand.
   d) A supplied-air respirator requires a trailing air hose that may further increase the worker's physical demand.
   e) A respirator such as a gas mask, supplied air respirators or self-contained breathing apparatus require connection and disconnection of parts and manipulation of valves and fittings during use. This, in turn, requires the ability to perform co-ordinated movements with the fingers.

2. The level of effort required of the worker.

   This may be evaluated by:

   a) Determining the worker's energy expenditure on the job.

      The workload level may be estimated by the type of work required of the worker, as shown in Table I.

   b) Determining the extent of usage of the respirator, e.g.

      - On a daily basis (if so, how many hours a day)
      - Occasionally, but probably more than once weekly
      - Rarely or for emergency situations only

3. Audio-visual requirement associated with the task.

   Determine visual and hearing acuity required to do the work while wearing the respirator.

B. Medical Factors

1. Medical conditions to be considered by the examining physician include:

   a) Respiratory Diseases

      - Chronic airflow limitation: chronic bronchitis, emphysema, asthma

        A worker with these conditions may be unable to breathe adequately against the additional resistance of a respirator. Coughing may lead to the removal of the respirator.

      - Restrictive lung disease

   b) Cardiovascular Diseases

      - Recent cardiac infarction
      - Significant arrhythmias, e.g. frequent premature ventricular contractions with a rapid pulse rate

   c) Emotional/Psychological Conditions

      Psychological factors must also be taken into consideration when workers are required to wear respirators. Some individuals become claustrophobic when wearing a respirator. These individuals should not be required to wear respirators if the condition is severe enough to cause panic.

d) Neurological Disease

Epilepsy, controlled on medication, should not be a disqualifying factor if the worker is seizure free for one year.

e) Musculo-Skeletal Conditions

- Hernia

This condition can be aggravated by wearing/carrying heavy respiratory protective equipment, e.g. SCBA.

- Restricted use of fingers or hands

Workers with missing or disabled fingers may be unable to operate respirators that require connection and disconnection of parts and manipulation of valves and fittings during use.

f) Other Conditions

- Defective eyesight
- Defective hearing/perforated tympanic membranes
- Uncontrolled diabetes with a history of recurrent sudden loss of consciousness
- Anemia with a history of recurrent fainting attacks
- Facial deformities
- Skin conditions that could be aggravated by occlusive materials

C. Medical Assessment

The physician's determination of the worker's ability to use a respirator should be based on an evaluation of the ability of the worker rather than on a diagnosed condition. Accordingly, medical tests, including physiological tests, may be required.

Medical History and Examination:

Lung – History of chronic airflow limitation (asthma or chronic bronchitis)
– Difficulty in breathing
– Previously documented lung problems

Heart – High blood pressure
– Arterial disease
– Documented heart problems

Other – Special senses
– Musculoskeletal
– Neurological
– Psychological

Clinical Tests:
Some, but not necessarily all, of the following investigations may be helpful for the objective assessment. As stated in the NIOSH reference, with an essentially normal clinical examination (history and physical), chest X-ray and spirometry data are, in most cases, 'unlikely to influence the respirator fitness determination; additionally, the X-ray would be an unnecessary source of radiation exposure.'

- Pulmonary Function tests
  - Spirometry
  - Maximal expiratory and inspiratory pressures (MEP and MIP) and maximal voluntary ventilation (MVV)
  - Oxyhemoglobin saturation during wearing of respirator
  - Exercise test during wearing of respirator with documentation of breathing pattern
- Chest X-ray
- ECG
- Blood tests, e.g. blood sugar, CBC
- Visual testing
- Audiometry

Table 1 **Some Selected Types of Work Classified According to Estimated Workload**

Workload
Level 1 – Resting
Level 2 – Light
Sitting at ease: light hand work (writing, typing, drafting, sewing, book keeping); hand and arm work (small bench tools, inspecting, assembly or sorting of light materials); arm and leg work (driving car under average conditions, operating foot switch or pedal). **Standing:** drill press (small parts); milling machine (small parts); coil taping; small armature winding; machining with light power tools; casual walking (up to 2 mph).
Level 3 – Moderate
Hand and arm work (nailing, filing); arm and leg work (off-road operation of trucks, tractors or construction equipment); arm and truck work (air hammer operation, tractor assembly, plastering, intermittent handling of moderately heavy materials, weeding, hoeing, picking fruits or vegetables); pushing or

Table 1 cont'd.

pulling light-weight carts or wheelbarrows; walking 2-3 mph.

Level 4 – Heavy

Heavy arm and truck work; transferring heavy materials; shovelling; sledge hammer work; sawing, planing or chiselling hardwood; hand mowing, digging, axe work; climbing stairs or ramps; jogging, running, walking faster than 4 mph; pushing or pulling heavily loaded hand carts or wheelbarrows; chipping castings; concrete block laying.

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ANSI – Z88.6-1984, American National Standard for respiratory protection – respirator use – physical qualifications for personnel.

CSA Z94.4 – M1982 Canadian Standard for Respirators.

NIOSH – Respirator Decision Logic, 1987 U.S. Dept. of Health and Human Services Publication No. 87-108.

A Guide for Physicians Examining Welders

A physician conducting a medical examination of a welder should be familiar with the nature of the welder's work, its potential hazards and possible health effects.

The following are occupational and medical factors to be considered by the physician while taking the medical/occupational history and conducting the medical examination.

A. Occupational Factors

1. Sources of Fumes and Gases

The fumes and gases from welding and flame cutting arise from a variety of sources:

- the metal in the filler rod, e.g. iron, aluminum, stainless steel (nickel or chromium), and the metal being welded;
- the metallic coating on the article being welded or on the filler rod, e.g. zinc, cadmium, and copper;
- any paint or grease on the article being welded;
- the flux coating on the filler rod, e.g. inorganic fluoride;
- the action of heat or ultraviolet light on the surrounding air, e.g. nitrogen dioxide, ozone, phosgene;

- the inert gas used as a shield, e.g. carbon dioxide, helium, argon.

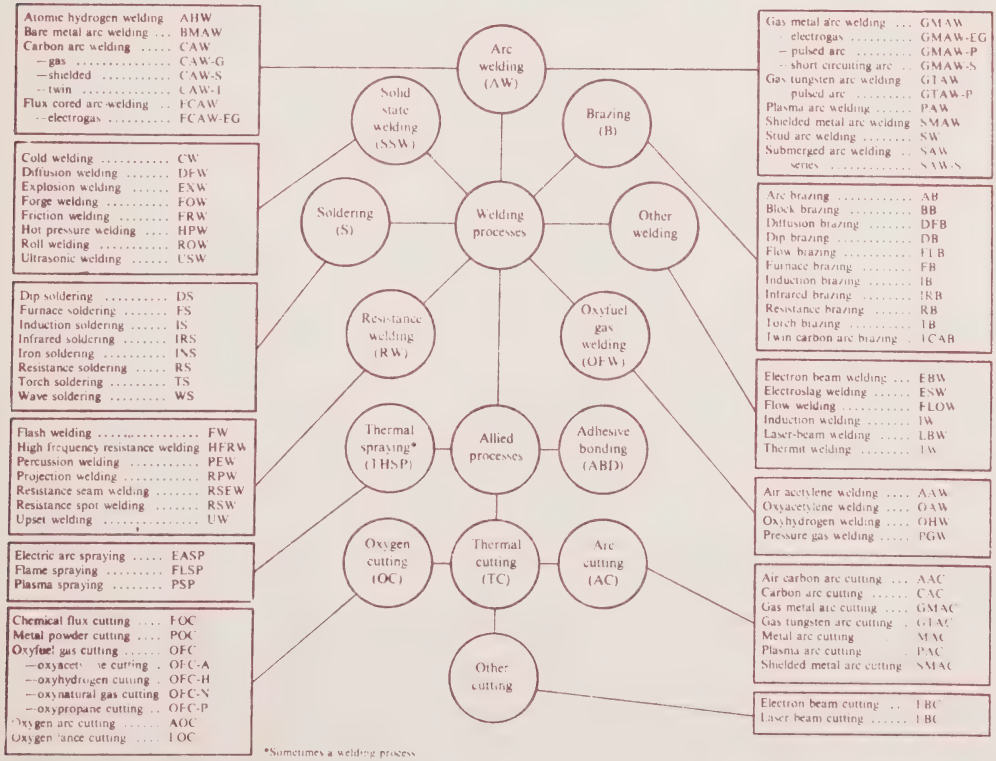
2. Type of Welding Performed

Figure 1 outlines the various welding and allied processes and their standard abbreviations.

Some processes are better known by other names, e.g.

- Shielded metal arc welding (SMAW) is also known as manual metal arc welding or stick welding. The electrode is a coated rod that melts into the pool of metal formed by the arc. Shielding is provided by ingredients in the electrode coating that decompose and generate a gaseous flow that keeps air from the arc.
- Gas-metal arc welding (GMAW) is sometimes called Metal Inert Gas welding because of the inert gases that were used with the process at first.
- Gas-tungsten arc welding (GTAW) may also be called Tungsten-inert gas welding (TIG).

Figure 1 Master Chart of Welding and Allied Process Showing Standard Abbreviations. (Courtesy American Welding Society.)


Welding processes
Arc welding (AW)
Solid state welding (SSW)
Brazing (B)
Soldering (S)
Other welding
Resistance welding (RW)
Oxyfuel gas welding (OFW)
Allied processes
Thermal spraying* (THSP)
Adhesive bonding (ABD)
Oxygen cutting (OC)
Thermal cutting (TC)
Arc cutting (AC)
Other cutting
Atomic hydrogen welding AHW
Bare metal arc welding ... BMAW
Carbon arc welding ..... CAW
—gas ..... CAW-G
—shielded ..... CAW-S
—twin ..... CAW-T
Flux cored arc welding .. FCAW
—electrogas ..... FCAW-EG
Cold welding ..... CW
Diffusion welding ..... DFW
Explosion welding ..... EXW
Forge welding ..... FOW
Friction welding ..... FRW
Hot pressure welding .... HPW
Roll welding ..... ROW
Ultrasonic welding ..... USW
Dip soldering ..... DS
Furnace soldering ..... FS
Induction soldering ..... IS
Infrared soldering ..... IRS
Iron soldering ..... INS
Resistance soldering ..... RS
Torch soldering ..... TS
Wave soldering ..... WS
Flash welding ..... FW
High frequency resistance welding HFRW
Percussion welding ..... PEW
Projection welding ..... RPW
Resistance seam welding ..... RSEW
Resistance spot welding ..... RSW
Upset welding ..... UW
Electric arc spraying ..... EASP
Flame spraying ..... FLSP
Plasma spraying ..... PSP
Chemical flux cutting .... FOC
Metal powder cutting .... POC
Oxyfuel gas cutting ..... OFC
—oxyacetylene cutting . OFC-A
—oxyhydrogen cutting . OFC-H
—oxynatural gas cutting OFC-N
—oxypropane cutting .. OFC-P
Oxygen arc cutting ..... AOC
Oxygen lance cutting .... LOC
Gas metal arc welding ... GMAW
—electrogas ..... GMAW-EG
—pulsed arc ..... GMAW-P
—short circuiting arc .. GMAW-S
Gas tungsten arc welding GTAW
pulsed arc ..... GTAW-P
Plasma arc welding ..... PAW
Shielded metal arc welding SMAW
Stud arc welding ..... SW
Submerged arc welding .. SAW
series ..... SAW-S
Arc brazing ..... AB
Block brazing ..... BB
Diffusion brazing ..... DFB
Dip brazing ..... DB
Flow brazing ..... FLB
Furnace brazing ..... FB
Induction brazing ..... IB
Infrared brazing ..... IRB
Resistance brazing ..... RB
Torch brazing ..... TB
Twin carbon arc brazing .. TCAB
Electron beam welding ... EBW
Electroslag welding ..... ESW
Flow welding ..... FLOW
Induction welding ..... IW
Laser-beam welding ..... LBW
Thermit welding ..... TW
Air acetylene welding .... AAW
Oxyacetylene welding .... OAW
Oxyhydrogen welding .... OHW
Pressure gas welding ..... PGW
Air carbon arc cutting ... AAC
Carbon arc cutting ..... CAC
Gas metal arc cutting .... GMAC
Gas tungsten arc cutting . GTAC
Metal arc cutting ..... MAC
Plasma arc cutting ..... PAC
Shielded metal arc cutting SMAC
Electron beam cutting .. EBC
Laser beam cutting ..... LBC
*Sometimes a welding process

3. Constituents in Fumes and Gases

Welders, depending on the type of welding used, may be potentially exposed to one or more of the following fumes and gases.

Contaminant	Source
Aluminum	Welding of aluminum.
Barium	Barium metal (rare) welding rods containing barium.
Beryllium	Beryllium copper alloys; spark proof tools.
Cadmium oxide	Silver solder; brazing; cadmium plated and painted surfaces.
Carbon monoxide	Carbon dioxide shieldings.
Cobalt	Cobalt steel; cobalt pigments.
Copper	Brass and bronze filler; base metal; plated surfaces; copper coated wire electrodes.
Chromium (VI)	Stainless steel metal and electrodes; chromium plated or painted surfaces.
Fluorides	Low-hydrogen electrodes; brazing flux.
Iron oxide	Welding of ferrous alloys.
Lead	Leaded steel and brass; lead painted surfaces.
Manganese	Manganese steel.
Molybdenum	Molybdenum steel.
Mercury	Marine paints.
Nickel	Stainless steel; nickel metal or electrodes; hard chrome plating.
Nitrogen Dioxide	Argon shielded welding on aluminum or stainless steel; flame processes.

Ozone	Argon shielded welding on aluminum, magnesium, titanium or stainless steel.
Phosgene	Chlorinated solvents.
Silica	Electrode coatings; castings.
Silver	Silver solder, silver plating.
Tin	Tin alloys.
Vanadium	Vanadium steel filler wire.
Zinc oxide	Galvanized steel.

B. Medical Factors

1. Health Effects Related to Welding Operations:

a) Acute Health Effects

Reported acute health effects are mainly restricted to the upper and lower respiratory tract system.

- Excessive exposure to ozone, oxides of nitrogen, phosgene and cadmium fumes have been reported to cause acute pneumonitis, bronchitis, pulmonary edema and fatalities. These exposures usually occur in confined space welding or when the identity of the combustibles is not known to the user.
- At low concentrations ozone causes eye and throat irritation.
- Occupational asthma has been reported among welders performing shielded metal arc welding of stainless steel, possibly due to chromium or nickel exposure. It has also been reported in welders using flux containing pine-pitch material (colophony).
- Metal fume fever (MFF) is an acute febrile, flu-like illness of short duration that results from inhalation of freshly formed metal oxides of copper, magnesium, iron, manganese, nickel, selenium, tin, antimony and, most commonly, zinc. This usually occurs four to eight hours after exposure, on the first day a new employee works or after a few days away from exposure (Monday Fever). The symptoms

include thirst, dry cough, metallic taste in the mouth, chills, dyspnea, malaise, muscle aches, headaches and, occasionally, vomiting. Fever and chills may be followed by sweating and, possibly, prostration, but these resolve by the next morning and the worker can return to work. The mechanism is unknown and the illness resolves leaving no apparent chronic disorder.

- Arc eye

b) Chronic Health Effects

Respiratory

- Mild obstructive airways disease

  Chronic pulmonary symptoms, particularly sputum production and cough, have been reported in welders, as has a reduction in pulmonary function (FEV_1, FEV_1/FVC ratio). The interaction of the effects of welding with cigarette smoking needs to be clarified.

- Siderosis

  This pneumoconiosis, due to pulmonary deposition of iron particles, has been reported in welders. Siderosis without fibrosis is considered to be benign. Fibrosis occurs if other dust is inhaled, particularly crystalline silica (mixed-dust pneumoconiosis).

- Lung cancer

  An association of lung cancer with welding operations has been observed. This could be due to the effect of all types of welding or to the presence of known carcinogens in certain processes, e.g. stainless steel welding, or to confounding factors.

Non-Respiratory

- Manganese exposure may cause chronic neurological disorders simulating Parkinson's disease.
- Chromium exposure may cause contact dermatitis
- Cadmium exposure may cause kidney disease
- Musculoskeletal
- Hearing loss
- Chronic eye effects

2. Medical Assessment

The medical history should include details of occupation(s) (including the use of respiratory protection) as well as respiratory and non-respiratory symptoms related to welding.

The systems to be examined may include:

- Respiratory
- Cardiovascular
- Dermatological
- Neurological
- Special senses

Clinical tests conducted for diagnostic or reference threshold purposes may include:

- Spirometry
- Chest X-ray
- Audiogram
- Special blood or urine analyses for heavy metals as and when appropriate.

3. Decision on Fitness

The physician's decision on fitness should be made only after careful consideration of the following criteria:

- The nature of the condition (occupational or otherwise)
- Whether exposure or continued exposure to the work environment is likely to aggravate the condition or cause further deterioration
- The requirements of the job
- Whether the condition is likely to endanger the worker's own safety or the safety of fellow workers
- The ability of the individual worker
- The availability of alternative employment opportunities within the same organization
- The worker's acceptance of restriction after explanation of the findings

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Update on the Educational Program in Occupational and Environmental Health

The Ontario ministries of Health, Labour, and the Environment have jointly sponsored a major educational program for professional staff within the three ministries and in closely related local and regional agencies. The venture has the support of both the Association of Local Official Health Agencies and the Ontario Public Health Association. Planning, implementing and evaluating this educational program has been done by a multidisciplinary group, with representatives from all three sectors, in co-operation with the Faculty of Health Sciences at McMaster University.

A series of nine regional workshops was held in the fall of 1987. The objectives were as follows:

1. To improve the knowledge and skills of public health practitioners in their management of environmental and occupational problems.
2. To facilitate communication on, and understanding of, roles and responsibilities between local public health and other government officials.
3. To encourage public health commitment to full participation in environmental and occupational health matters.

The workshops had 350 participants with representatives from the three sectors, as follows:

Health	226
Environment	47
Labour	47

Thirty other participants, mainly from police and fire departments, and including community groups, provided useful input from their own perspectives.

The evaluation report, prepared by McMaster University, demonstrated that all the objectives of the workshops were met. There were significant changes in some pre- to post-workshop measurements, specifically, an increased confidence in dealing with an environmental incident such as a chemical spill or explosion and an increased knowledge about the type

and quality of information required for action. Procedures for communicating with the public and effectively using a support network of other professionals were also better understood. For subsequent workshops, the evaluation format will be somewhat modified to provide a structure for quantitative analysis.

A major symposium held in May 1988 was well attended and generally regarded as successful. Participants rated almost all of the sessions very highly in terms of quality of presentation, relevance and quantity of new information.

At this point in the program, two new training modules have been developed and are almost ready for use. One of these is for in-house training (indoor air quality) and the other (landfill site problems) is for use in regional workshops in the fall of 1988.

Coming Events

February 1989	Assessments of Inhalation Hazards: Integration and Extrapolation Using Diverse Data. For further information, contact: Prof. Dr. med. U. Mohr, Hanover Medical School, Institute of Experimental Pathology, Konstanty-Gutschow-Str. 8, D-3000 Hanover 61, Federal Republic of Germany.
March 16–17, 1989	First International Conference on Health Related Effects of Phyllosilicates. PARIS, FRANCE. For further information, contact: Prof. J. Bignon, INSERM U 139, Chu H. Mondor, 94010 Creteil cedex, France.
April 11–14, 1989	BOHS Annual Conference. WARWICK, ENGLAND. For further information, contact: BOHS Secretariat, 1 St. Andrew's Place, Regent's Park, London, England, NW1 4LB.
April 17–20, 1989	IAQ-89: The Human Equation: Health and Comfort. SAN DIEGO, CA., U.S.A. For further information, contact: Jim Norman, Manager of Technical Services, ASHRAE, 1791 Tullie Circle, N.E., Atlanta, GA, USA, 30329.
April 19–21, 1989	International Symposium: Vibration at Work. VIENNA, AUSTRIA. For further information, contact: Secretariat, Allgemeine Unfallversicherungsanstalt, Kongressbüro, Adalbert-Stifter-Strasse 65, A-1200 Wien, Austria. Phone: (0222) 3301/537, 3301/558, Telex 136074.
May 18–19, 1989	10th European Conference on Environmental Pollution. CAPRI, ITALY. For further information, contact: Dr. V.M. Bhatnagar, P.O. Box 1779, Cornwall, Ontario, Canada, K6H 5V7.
May 21–26, 1989	1989 American Industrial Hygiene Conference. ST. LOUIS, MO., U.S.A. For further information, contact: AIHC, 475 Wolf Ledges Pkwy., Akron, OH, U.S.A. 44311 1087, Phone (216) 762-7294.

May 22–26, 1989	Second Meeting of the International Neurotoxicology Association. SITGES, BARCELONA, SPAIN. For further information, contact: Dr. E.R. Farré, Secretariat II INA Meeting, Department of Pharmacology and Toxicology, CSIC, Jorge Girona Salgado, 18–26, E-08034 Barcelona, Spain.
June 5–9, 1989	Annual International Industrial Ergonomics and Safety Conference '89. CINCINNATI, OHIO, U.S.A. For further information, contact: Professor Anil Mital, Conference Chairman, Mechanical and Industrial Engineering Department, University of Cincinnati, Cincinnati, OH, U.S.A. 45221-0072. Phone: 513/475-6249 or 475-2738.
June 8–9, 1989	9th International Symposium on Environmental Pollution. TORONTO, ONTARIO, CANADA. For further information, contact: Dr. V.M. Bhatnagar, P.O. Box 1779, Cornwall, Ontario, Canada, K6H 5V7.
June 24–28, 1989	1989 Annual Meeting — American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). VANCOUVER, BRITISH COLUMBIA, CANADA. For further information, contact: Continuing Education and Chapter Programs, ASHRAE, 1791 Tullie Circle, NE, Atlanta, GA, U.S.A., 30329. Phone: 404/636-8400.
August 28–30, 1989	International Conference on Blood-Borne Infections in the Workplace. STOCKHOLM, SWEDEN. For further information, contact: International Conference on Blood-Borne Infections, CONGREX AB, P.O. Box 5619, S-114 86 Stockholm, Sweden.
August 28–September 1, 1989	CLIMA 2000—Second World Congress on heating, ventilation, air conditioning and refrigeration. SARAJEVO, YUGOSLAVIA. For further information, contact: CLIMA 2000, Masinski Fakultet, Prof. Dr. E. Kulic, 71000 Sarajevo, Omladinsko Staliste 66, Yugoslavia.
September 11–14, 1989	Work with Display Units 89. MONTREAL, QUEBEC, CANADA. For further information, contact: General Secretary, Institut de recherche en santé et en sécurité du travail du Québec (IRSST), 505 boulevard de Maisonneuve ouest, Montréal, Québec, Canada, H3A 3C2.

October 3–6, 1989	Occupational Medical Association of Canada—Annual Meeting. HALIFAX, NOVA SCOTIA, CANADA. For further information, contact: Dr. F. Mills, Corporate Medical Director, John Labatt Ltd., P.O. Box 5870, London, Ontario, Canada, N6A 5L3.
November 16–17, 1989	International conference on Air, Water and Environmental Pollution and Hazardous Wastes. NEW DELHI, INDIA. For further information, contact: Dr. V.M. Bhatnagar, P.O. Box 1779, Cornwall, Ontario, Canada, K6H 5V7.
September 22–29, 1990	23rd International Congress on Occupational Health. MONTREAL, QUEBEC, CANADA. For further information, contact: Dr. M. Lesage, Chairman of the Organizing Committee, 84 rue de Brésoles, Montréal, Québec, Canada. H2Y 1V5.

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